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Irradiance distribution in the image of a tube electrothermal atomizer[1]

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Abstract

An algorithm is proposed that allows the calculation of irradiance distribution in the image of a three-dimensional emitter formed by an imaging mirror. The approach is based on a rigorous ray-tracing algorithm supplemented with calculation of radiant flux transferred along each ray. Based on the algorithm, a computer program has been developed to model image formation of a tube electrothermal atomizer in a conventional atomic absorption spectrometer. Image formation of an isothermal and non-isothermal furnaces with and without platform has been considered. The effect of the atomizer misalignment on the irradiance distribution in the image has been modeled. © 1997 Elsevier Science B.V.

Keywords: Ray-tracing; Electrothermal atomizer; Imaging; Algorithm

1. Introduction

From the optical point of view, most of the atomic absorption (AA) spectrometers are designed in a way that the image of a primary source is focused on the atomizer center. Then the combined images of the atomizer and the source are further projected onto the entrance slit of the monochromator and then onto the detector. Thus there is a complex pattern of irradiance on the detector surface formed by the superimposed images of the primary source and the luminous atomizer walls and platform. This pattern rapidly changes in time when fast heating the tube. The detection system of a conventional AA spectrometer is based on the use of spatially integrating detectors such as photomultiplier tubes or photodiodes. The detectors provide excellent temporal resolution of transient intensities but spatially integrate all the radiation falling on their working surface. Therefore emission from incandescent tube walls and the platform should be rejected before reaching the detector. In a graphite furnace AA spectrometer it is normally achieved by the use of so-called low slits at the monochromator's entrance. The height of this low slit is a compromise between efficient blocking of radiation from the atomizer and high throughput of radiation from the primary source. The irradiance distribution on the detector surface should be known for making the compromise. Optimization of light throughput of a spectrometer is traditionally performed by the use of ray-tracing programs and the drawing of spot diagrams [1–4].

Recent attempts to make AA spectrometry spatially resolved further increase the need to know the irradiance distribution on the detector surface. Replacement of a single photodiode (or a photomultiplier tube) by a photodiode array located along the exit slit of the monochromator allows not only temporal but also spatial resolution of the transmitted intensities [5,6]. Atomizer emission is directly related

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